3.0 FLOW PROJECTIONS

3.1 2000 Comprehensive Plan

The Spotsylvania County 2000 Comprehensive Plan was adopted by the Board of Supervisors in February 2002. The 2000 Comprehensive Plan adjusts the boundaries of the primary settlement area, eliminates the secondary settlement area, and designates a new Thornburg Development District. Each of these three land use adjustments impact the Spotsylvania County water and sewer systems.

3.2 Zoning and Land Use

Each property within Spotsylvania County has been placed in a zoning district according to the policies of Chapter 23, Zoning, of the Spotsylvania County Code, published by order of the Board of Supervisors. The Code defines the purpose and intent, permitted uses, and development standards for each of the zoning districts. The zoning was used in projecting the flows for undeveloped properties. Each zoning type has a projected density based on the Code and the Spotsylvania County Build-Out Analysis. Projected demands were defined using the existing zoning or by adjusting the zoning from one district to another, the projections can be adjusted for future development.

3.3 Residential Development Densities

Residential development densities have been published by Spotsylvania County within a Zoning Build-Out Analysis dated September 17, 1999, created by the Planning Department. A copy of the Zoning Build-Out Analysis is appended to this document. The Build-Out Analysis defines a density for land parcels based on the residential zoning designation and other County policies that affect residential location and density. Table 1 recreates a table from the Build-Out Analysis that defines the values used in developing future demand projections.

Table 3.1 – Residential Land Use Densities

Zoning	Density
RR	1 unit per 1.7 acres
A3	1 unit per 6.2 acres
A2	1 unit per 4.6 acres
Ru	1 unit/3.08 acres
R1	2 units/acre
R2	2.5 units/acre
R3	2.5 units/acre
PDH X	X units/acre

The Build-Out Analysis only defines the density requirements for residential property. Commercial and industrial properties vary depending on the type of business or industry.

3.4 Primary Settlement Area Boundary

The Massaponax Creek drainage basin makes up a large portion of the primary settlement area. Additionally, portions of the Hazel Run drainage basin, Deep Run drainage basin, several small areas that drain to the Rappahannock River, the Courthouse Area, and American Central area are (or soon will be) pumped into the Massaponax Creek interceptor for treatment at the Massaponax WWTP. These areas comprise the primary settlement area.

The Hazel Run drainage basin flows by gravity to the City of Fredericksburg. The City pumps to the FMC WWTP a quantity of screened raw sewage equivalent to the quantity of sewage flowing from Spotsylvania County into the City's Hazel Run Trunk Sewer and meter station, plus up to 1.5 mgd of sewage generated in the City, according to the 1983 City-County Annexation Agreement. Presently, existing sewage pumping stations in Hazel Run subbasins HR-16 through HR-20 along Route 3 convey sewage out of the Hazel Run drainage basin to the Massaponax Creek interceptor.

3.5 Comprehensive Plan Adjustments to Primary Settlement Area Boundary

The Spotsylvania County 2000 Comprehensive Plan alters the primary settlement area boundary. Part of the Massaponax Creek drainage basin to the south of U.S. Route 17 has been removed from the primary settlement area and placed in a Rural Development District. The areas removed from the primary settlement area are designated in the Master Plan Revisions as sub-basins MC-1, MC-2, MC-3, MC-4, MC-5, MC-6, and MC-7.

In addition, three sub-basins, draining directly to the Rappahannock River east of Route 2, have been removed from the primary settlement area. These basins, designated RR-1, RR-2, and RR-3 in the Master Plan Revisions, are placed in a Rural Development District.

A third boundary adjustment was made to the primary settlement area at the Lick Run basin within the Massaponax Creek drainage area. The parcel west of Lick Run and east of the military park, within a sub-basin designated MC-53, has been removed from the primary settlement area and placed in a Rural Development District.

3.6 Thornburg Development District Boundary

The Spotsylvania County 2000 Comprehensive Plan eliminates the designation of the secondary settlement district, previous identified as the Ni River and Po River basins. In its place, the Plan defines the Thornburg Development District. The Thornburg Development District is the area along Route 1 south of the primary settlement area. The area includes sub-basins of the Ni River, Po River and Matta River drainage basins which front Route 1. The areas within these river basins not falling in the Thornburg Development District or in the Courthouse Area have been designated as part of the Rural Development District.

The Comprehensive Plan directs that commercial and industrial develop predominate in this area, with less than 50% of the area designated for residential development. The Comprehensive Plan designates capability to implement new water and sewer service to the area in response to requirements of industrial prospects or customers and envisions industrial water and sewer demands that cannot be met by the existing Thornburg infrastructure.

3.7 Water Demand Projection Methodology

The following outline defines the methodology utilized to develop water demand projections for the 2002 Water/Sewer Master Plan Revisions:

Step 1 – Define Sub-Basin Boundaries

1. An AutoCAD planimetric and parcel line drawing was prepared for Spotsylvania County.

2. The existing sewage pump station location drawing was overlaid on the planimetric drawing.

3. The planimetric/parcel line/sewage pump station drawing was plotted over a raster image background of the County topographic features. The developable portion of Spotsylvania County was divided into 8 sheets and plotted.

4. Sub-basins boundaries were developed for each of the sewage pump stations. Initial boundaries were corrected by the Spotsylvania County Utilities Department.

5. Sub-basin boundaries for the remainder of the primary settlement area and Thornburg Development District were created. All sub-basin boundaries were created as a closed polygon. All sub-basins are contained within the drainage areas of Deep Run, Hazel Run, Massaponax Creek, Ni River, Po River, Matta River, or the Rappahannock River. The drainage areas were distributed as follows:

   Massaponax Creek: 63 sub-basins (primary settlement area)
   Hazel Run: 17 sub-basins (primary settlement area)
   Deep Run: 7 sub-basins (primary settlement area)
   Rappahannock River: 5 sub-basins (primary settlement area)
   Ni River: 5 sub-basins (Thornburg Development District)
   Po River: 7 sub-basins (Thornburg Development District)
   Matta River: 3 sub-basins (Thornburg Development District)
   American Central: 20 sub-basins (pumped into Massaponax Creek basin)

Step 2 – Develop Water Use Demand

1. Spotsylvania County water use records were matched with E911 addresses, using the physical address listings in each file. Approximately 85% of the water records could be matched to an E911 file.

2. Some water record addresses could not be matched to an E911 address. A greater number of E911 addresses did not coincide with a water record address; the majority of these were located in the secondary settlement area or in the rural sections of the County, where County water service is not proved. However, there were some E911 addresses in the primary settlement area, which did not coincide with a water record address. These discrepancies presumably occurred because E911 addressing, which was completed between 1995 and 1997, changed some street names and addresses and these changes have not been reflected on the water service records.

3. The two address lists were reconciled, with the support of the Spotsylvania County Utilities Department. All but 1924 records were reconciled. Of these records, approximately 98% could be attached to an E911 address and located within a sub-basin. The remaining 128 water records could not be identified to a specific drainage area and were ignored.

4. The reconciled water records and E911 addresses were used to determine the actual water demand in each sub-basin for the 12-month period from June 1998 to May 1999.

Step 3 – Project Future Demand

1. At ultimate build-out, the entire primary settlement area and the Thornburg Development District are assumed to be 100% developed. Existing subdivision were assumed to be fully developed and currently undeveloped areas of the County were assumed to be developed according to current zoning.

2. Using AutoCAD, polygons were constructed around existing subdivisions which are fully developed, or which appear to be more than 80% developed. These areas were assumed to already be at maximum development density and water demand. If an E911 address which does not have a corresponding water record falls within the fully developed subdivision, an assumed water demand was applied to the address, equal to the average daily water demand for the sub-basin.

3. An average daily residential water use for the existing connections was determined. In each of the three major drainage basins (Hazel Run, Deep Run, and Massaponax Creek), up to five sub-basins were chosen. For each of these sub-basins, three fully-developed streets (at least 10 connections) were selected and the average water use per connection was calculated. A total of 37 residential streets throughout the developed portion of the County were monitored. The average daily residential water use averaged 195 gpd/connection and varied from 107 gpd/connection to 290 gpd/connection. On the basis of this exercise and with guidance from the Spotsylvania County Utilities Department,

the average water demand for existing residential connections was established at 200 gpd/connection. This demand was used to define the build-out water demand within undeveloped residential portions of each sub-basin.

The 200-gpd per residential connection is the average annual dry weather water demand. For sanitary sewer design, a 50-percent infiltration allowance was added to the water demand to define the average daily sewage flow per residential connection. The resulting 300 gpd/connection accounts for variations in residential demands and infiltration and inflow additions. This value exceeds the 240-gpd minimum sewage demand per residential connection recommended by the Virginia Department of Health, Office of Water Programs, in a January 23 2001 letter.

4. Commercial zoning has three categories: C1 (low intensity), C2 (medium intensity), and C3 (high intensity). In the primary settlement area and Thornburg Development District, the C1 commercial is very localized, typically by single property, and is generally already fully developed. The larger undeveloped commercial areas are zoned C2 and C3. Build-out water demands in C1 properties were assumed to match existing water demand. Water demand at full development for C2 properties was defined by the determining the water demand of an existing fully developed C2 property on Route 3 and water demand at full development for C3 properties was defined by determining the demand of an existing fully developed C3 property on Route 1. These commercial water demands were applied to undeveloped commercial areas to determine the build-out water demand for each sub-basin, as follows:

   - 625 gpd/acre at full development for C2 properties
   - 1000 gpd/acre per acre at full development for C3 properties

5. The build-out water demand of each sub-basin were computed using the following logic. ArcView was used to compute the total area within each sub-basin, using polygons set up in AutoCAD. The developed subdivision areas were computed and subtracted from the total area of the sub-basin. The developed subdivisions areas are defined as those where build-out water demand has already been established. The remaining area of the sub-basin is defined as the undeveloped area. The undeveloped area within each sub-basin, for each zoning category, was computed.

   Using the Residential Build-out Analysis provided by Spotsylvania County, a build-out number of residences was assigned to each undeveloped residential zoning area within a sub-basin. Using the County average residential water demand, the build-out water demand was calculated. Residential Build-out Analysis is:

   - R1 development density is 2.0 dwelling units per acre
   - R2 and R3 development density is 2.5 dwelling units per acre
   - County average water demand is 200 gpd/connection

   Build-out water demand in undeveloped commercial areas was determined by multiplying the C2 and C3 acreage by 625 gpd/acre and 1000 gpd/acre respectively.

Build-out industrial demands were computed on a site-by-site basis. Build-out water demand for each sub-basin was defined as the calculated undeveloped residential, commercial and industrial demand plus the demand from the fully developed subdivision water demand, taken from the actual water records.

Step 4 – Coordinate Present and Future Demands

Current water demand and build-out water demand (based on current zoning) for each sub-basin were compared to identify discrepancies. Four sub-basins were identified with build-out water demand less than present day demand. Other sub-basins had a small increase in water demand, despite having a large undeveloped land area. For each sub-basin the current and build-out water demands and the current zoning designation for developed areas not fully build-out were analyzed. Two required refinements to the build-out water demand methodology were identified as follows:

- Existing subdivisions, which are not yet fully developed, have greater lot densities than allowed by zoning regulations and County of Spotsylvania Residential Build-out Analysis. Specifically, subdivisions with ½ to 1-acre lots were being developed on areas designated RU (1 lot per 3 acres). The actual number of lots were as much as six times the number of lots indicated by the zoning designation.

- In several sub-basins, "Open Space" has been designated for flood plains along major creeks, space adjacent to cluster housing or apartments, parks, and school property. Current water demand falls within the open space; although, open space has no build-out water demand. The open space designations were reviewed to determine if they were appropriate or if future development were possible.

Step 5 – Adjust Current Zoning

Changes to current zoning in each sub-basin were made to better define the build-out water demand potential. Areas with "Open Space" designations were located and designated properly. Some areas were changed from RU to R1 or R2 zoning, to more accurately represent the lot sizes of partially developed or adjacent subdivisions. A complete tabulation of current zoning adjustments by sub-basin in appended to this report.

3.8 Alternative Build-Out Water Demands

The build-out water demands in Spotsylvania County were mapped for two alternative scenarios. The first alternative is based on development of the primary settlement area and Thornburg Development District according to current zoning. To allow for increased development along major transportation routes, a second alternative was developed based on greater development density along properties fronting US Routes 1 and 17 and Virginia Routes 3 and 208. To simulate the greater development density, all fronting properties currently zoned A2, A3, or RU (density of 2-5 acres per lot) were changed to R1 (0.5 acres per lot). All properties not fronting one of the four highways were not modified.

The second alternative provides the most realistic and conservative approach to future development and was used to develop water and sewer demands.

3.9 Water Demands for Each Drainage Area Sub-basin

Below is a tabulation of average annual water demands for each drainage area sub-basin. The tabulation includes the existing water demand (based on actual water demand in each sub-basin for the 12-month period from June 1998 to May 1999), the estimated future water demand assuming full development in the Primary Development Area, and the estimated sewer flow including a 50-percent infiltration and inflow factor.

Table 3.2 - Water Demands and Sewer Flows Within Massaponax Creek Drainage Basin

Sub-basin	Existing Water Demand (gpd)	Build-out Water Demand (gpd)	Build-out Sewer Flow (gpd)
MC-01A	0	113661	128014
MC-01B	0	0	0
MC-02A	0	188613	282920
MC-02B	0	0	0
MC-03	299	299	299
MC-04	1858	1858	1858
MC-05	0	0	0
MC-06	0	0	0
MC-07	0	0	0
MC-08	1066	78841	90114
MC-09	2898	254349	278532
MC-10	624	39494	59241
MC-11	2233	23133	32941
MC-12	71780	235151	306492
MC-13	3329	269017	289637
MC-14	10593	220798	269269
MC-15	17101	212746	219219
MC-16	58609	115971	159343
MC-17	92632	139463	178460
MC-18	83377	98807	107753

MC-19	105331	123953	157762
MC-20	82944	172867	172867
MC-21	121441	233083	251986
MC-22	128680	294779	319104
MC-23	4924	184409	192067
MC-24	30901	57177	61655
MC-25	52353	119475	134315
MC-26	13441	421277	426831
MC-27	44561	458038	471040
MC-28	69119	72592	85155
MC-29	54187	316573	331572
MC-30	0	23925	35416
MC-31	23	96916	111200
MC-32	119776	166355	184955
MC-33	96830	119963	134091
MC-34	97209	113105	151458
MC-35	115271	139154	157254
MC-36	41674	194197	273089
MC-37	25281	81601	109873
MC-38	78401	96269	115490
MC-39	48793	83559	104943
MC-40	120542	152546	170184
MC-41	4753	119587	169538
MC-42	62941	84868	97136
MC-43	1556	185589	274781
MC-44	139841	141058	163303
MC-45	57898	113600	145863
MC-46	102310	162663	191083
MC-47	43577	45265	50213
MC-48	71762	111654	132742
MC-49	75602	161109	215994

MC-50	2516	39865	58065
MC-51	32701	44357	50519
MC-52	349	177220	254355
MC-53	0	407719	583006
MC-54	0	39104	51056
MC-55	252	19188	28726
MC-56	8617	8617	8984
MC-57 *	18280	58641	75533
MC-58 *	0	16388	24582
MC-59 *	0	25280	37920
MC-60	1601	60302	64923
MC-61	0	180904	180904
MC-62	52427	342097	455624
MC-63	23496	194503	259590
TOTAL	2,498,560	8,453,592	10,130,839

Sub-basins MC-57, MC-58 and MC-59 are within the Hazel Run drainage basin, but are sewered by pumping into the Massaponax Creek drainage basin. Below is a tabulation of these three sub-basins.

Table 3.3 – Hazel Run Sub-Basins Pumped to Massaponax Creek Drainage Basin

Sub-basin	Existing Water Demand (gpd)	Build-out Water Demand (gpd)	Build-out Sewer Flow (gpd)
MC-57	18280	58641	75533
MC-58	0	16388	24582
MC-59	0	25280	37920
TOTAL	18,280	100,309	138,035

Table 3.4 – Water Demands and Sewer Flows Within American Central Drainage Basin

Sub-basin	Existing Water Demand (gpd)	Build-out Water Demand (gpd)	Build-out Sewer Flow (gpd)
FL-01	37755	63130	94686
FL-02	13877	34786	45990
FL-03	7882	17972	26957
FL-04	5341	44652	66977
FL-05	25738	58339	76065
FL-06	0	74532	111797
FL-07	0	63412	95117
FL-08	0	44409	66613
FL-09	157	6514	8238
FL-10	107	5780	8639
FL-11	0	3224	3256
FL-12	268	11516	16975
FL-13	0	4354	4514
FL-14	0	22413	33233
FL-15	0	10853	16234
FL-16	0	12931	12932
FL-17	0	7696	11544
FL-18	14989	14989	14989
FL-19	25225	27885	29216
FL-20	62208	63912	64835
TOTAL	193,547	593,299	808,807

Table 3.5 - Water Demands and Sewer Flows Within Rappahannock River Drainage Basin

Sub-basin	Existing Water Demand (gpd)	Build-out Water Demand (gpd)	Build-out Sewer Flow (gpd)
RR-01A	0	70679	70679
RR-02A	0	69096	69096

RR-03	0	0	0
RR-04	37211	255754	304758
RR-05	29045	31637	33119
TOTAL	66,256	427,166	477,652

Table 3.6 - Water Demands and Sewer Flows Within Hazel Run Drainage Basin

Sub-basin	Existing Water Demand (gpd)	Build-out Water Demand (gpd)	Build-out Sewer Flow (gpd)
HR-01	134941	324018	394120
HR-02	42187	179510	181214
HR-03	22109	50567	74337
HR-04	30378	103590	103984
HR-05	119334	191594	229789
HR-06	14639	61610	85506
HR-07	178195	279303	353272
HR-08	271693	271693	271693
HR-09	31390	42250	47804
HR-10	66238	152124	223059
HR-11	0	94620	141931
HR-12	918	35545	50343
HR-13	48666	65654	70266
HR-14	162809	162809	162809
HR-15	41719	85369	108782
HR-16	149217	172785	195555
HR-17	19635	29792	35664
TOTAL	1,334,068	2,302,833	2,730,128

Table 3.7 - Water Demands and Sewer Flows Within Deep Run Drainage Basin

Sub-basin	Existing Water Demand (gpd)	Build-out Water Demand (gpd)	Build-out Sewer Flow (gpd)
DR-01	8306	192958	198928
DR-02	4073	196319	203752
DR-03	18439	303682	303682
DR-04	106442	181973	206918
DR-05	78983	133282	154269
DR-06	93441	346919	435019
DR-07	9679	10854	11314
TOTAL	319,363	1,365,987	1,513,882

Table 3.8 - Water Demands and Sewer Flows Within Ni River Drainage Basin

Sub-basin	Existing Water Demand (gpd)	Build-out Water Demand (gpd)	Build-out Sewer Flow (gpd)
NI-01	0	0	0
NI-02	0	0	0
NI-03	0	0	0
NI-04	0	0	0
NI-05	0	0	0
NI-06	0	0	0
NI-07	0	0	0
NI-08	0	0	0
NI-09	208	208	208
NI-10	0	0	0
NI-11	0	0	0
NI-12	5885	669133	963000
NI-13	0	212694	275255
NI-14	0	26730	40095
NI-15	0	0	0

NI-16	0	0	0
NI-17	180	180	180
NI-18	0	0	0
NI-19	0	0	0
NI-20 *	111161	411070	561612
NI-21	877	877	877
NI-22	15045	15045	15045
NI-23 *	1534	112694	167082
NI-24 *	2615	37334	56002
NI-25	35342	35342	35342
NI-26	0	0	0
NI-27	5127	5127	5127
NI-28	3427	3427	3427
NI-29	25734	25734	25734
TOTAL	207,135	1,555,595	2,148,986
Courthouse Area	115,310	561,098	784,696
Thornburg Development District	91,825	994,497	1,364,290

* Courthouse Area contains sub-basins NI-20, NI-23 and NI-24, as well as sub-basins PO-17 and PO-18. These sub-basins are sewered by pumping to the Massaponax Creek drainage basin. Other sub-basins in the Ni River drainage basin, for which demands are defined, are contained within the Thornburg Development District.

Table 3.9 - Water Demands and Sewer Flows Within Po River Drainage Basin

Sub-basin	Existing Water Demand (gpd)	Build-out Water Demand (gpd)	Build-out Sewer Flow (gpd)
PO-01	0	72996	103844
PO-02	7764	144761	217141
PO-03	22051	271049	329744
PO-04	6486	430418	564297
PO-05	4421	265016	397524
PO-06	0	75707	113561
PO-07	0	6587	9881
PO-08	0	0	0
PO-09	0	20691	31037
PO-10	0	0	0
PO-11	0	0	0
PO-12	0	0	0
PO-13	0	0	0
PO-14	0	0	0
PO-15	0	0	0
PO-16	0	0	0
PO-17 *	51262	171684	232784
PO-18 *	4730	67153	98364
TOTAL	96,714	1,526,062	2,098,177
Courthouse Area	55,992	238,837	331,148
Thornburg Development District	40,722	1,287,225	1,767,029

* Courthouse Area contains sub-basins PO-17 and PO-18, as well as sub-basins NI-20, NI-23 and NI-24. These sub-basins are sewered by pumping to the Massaponax Creek drainage basin. Other sub-basins in the Ni River drainage basin, for which demands are defined, are contained within the Thornburg Development District.

Table 3.10 - Water Demands and Sewer Flows Within Matta River Drainage Basin

Sub-basin	Existing Water Demand (gpd)	Build-out Water Demand (gpd)	Build-out Sewer Flow (gpd)
MR-01	869	165689	213467
MR-02	0	74320	81451
MR-03	1943	229834	308451
TOTAL	2,812	469,843	603,369

3.10 Spotsylvania County Build-Out Water Demands

Below is a summary tabulation of the build-out average annual water demands for each drainage basin in the Spotsylvania County primary settlement area and Thornburg Development District.

Table 3.11 – Summary of Water Demands and Sewer Flows By Drainage Basins

Drainage Basin	Existing Demand (gpd)	Build-out Water Demand (gpd)	Build-out Sewer Flow (gpd)
Massaponax Creek	2,498,560	8,453,592	10,130,839
American Central	193,547	593,299	808,807
Courthouse Area	171,302	799,935	1,115,844
Rappahannock River	66,256	427,166	477,652
Hazel Run	1,334,068	2,302,833	2,730,128
Deep Run	319,363	1,365,987	1,513,882
Ni River, Thornburg Development District	91,825	994,497	1,364,290
Po River, Thornburg Development District	40,722	1,287,225	1,767,029
Matta River	2,812	469,843	603,369
TOTAL	4,718,455	16,694,378	20,511,842

3.11 Water Demand Allocation Methodology

The existing and build-out Spotsylvania County average annual water demands were developed and defined by drainage sub-basins as defined in section 3.9 above. Although drainage sub-basins were used to evaluate sewer improvements and expansion, an alternative node and pressure zone allocation methodology was used for the purpose of water system hydraulic modeling. The City of Fredericksburg demand projections were taken from the City's "Water Master Plan" by Whitman, Requardt and Associates. The process employed to allocate existing demands is as follows:

- Obtain an ArcView shape file containing the drainage sub-basin polygon coverage;
- Obtain the ArcView shape file containing the reconciled 911 and meter account point data;
- Export the Cybernet hydraulic model to an ArcView shape file coverage;
- Draw individual polygons, each encompassing one Cybernet model junction node and the spatially closest water demand point data;
- Develop a script which sums the individual demand point data values and allocates them to the Cybernet model junction node within the polygon; and
- Add 10% to average day demands for unaccounted losses.

To develop the build-out demand data from Scenario 2 for use in the hydraulic model the following process was used:

- Overlay the ArcView polygon drainage sub-basin shape file and the hydraulic model shape file;
- Generate a table listing the individual model nodes located within each drainage sub-basin;
- Generate 1999 average day to build-out average day peaking factors for each drainage sub-basin where water service currently exists;
- Using these peaking factors and a Cybernet ODBC connection import the corrected build-out demand for the developed drainage sub-basins;
- Identify all non-allocated demands and input junction demands into the hydraulic model; and
- Add 10% to average day demands for all unaccounted losses.

3.12 County and City Pressure Zone Water Demands

Upon conversion of the drainage sub-basin Scenario 2 data to Cybernet node demand data, the average day existing and build-out water system demands were peaked to obtain maximum day and peak hour demands. Spotsylvania County maximum day peaking factor of 1.674 was developed from historical record data, while the City of Fredericksburg peaking factor (1.6) was taken from the City's most current modeling data. The table below shows water demand data.

Table 3.12 - Water Demand Data By Pressure Zones

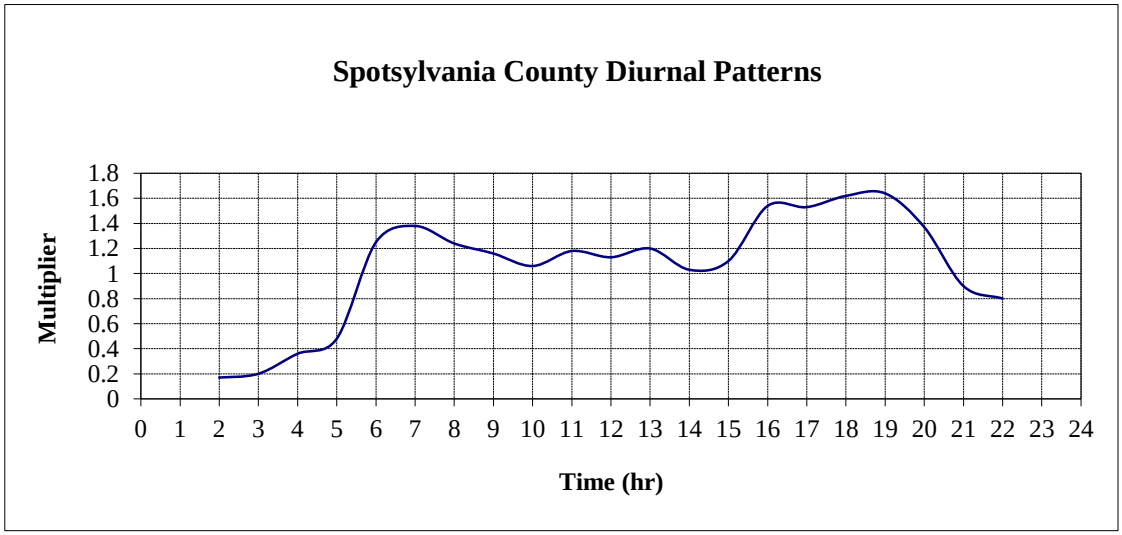
Pressure Zones	1999 Average Day Demand (mgd)	1999 Maximum Day Demand (mgd)	Build-out Average Day Demand (mgd)	Build-out Maximum Day Demand (mgd)
Spotsylvania County				
Five Mile Fork	1.51	2.53	2.96	4.29
Battlefield	2.37	3.97	9.06	14.93
Mine Road	0.35	0.59	3.55	4.54
City	0.46	0.77	0.76	1.91
American Central	0.04	0.06	0.36	0.59
Thornburg			3.00	3.00
Other	0.03	0.05	0.03	0.05
Total	4.76	7.97	19.72	29.31
City of Fredericksburg				
Courtland	1.03	1.65	2.37	3.79
College	0.38	0.61	0.38	0.61
Downtown	1.12	1.79	1.13	1.81
Other			0.37	0.59
Total	2.53	4.05	4.25	6.80
System Total	7.29	12.02	23.97	36.11

*City of Fredericksburg Hydraulic Model – Whitman, Requardt and Associates

The Spotsylvania County 1999 average day water demand total of 4.76 mgd closely matches the total in the table in Section 3.11 of 4.72 mgd, with the difference being less than 1% caused by rounding. For the same reason, the build-out average day demand total of 19.72 mgd (which includes a 3-mgd Thornburg industrial demand not included in the figures in Table 3.11) and the value in the Table in Section 3.11 of 16.69 mgd is less than 1% difference when taking the Thornburg industrial demand into account.

A peaking factor of 2.75 times average daily demand was used to obtain the peak hour demand. This factor represents the maximum hour (as defined by the County's diurnal usage curve, below) on the maximum demand day.

Figure 2 – Water Demand Hourly Diurnal Pattern



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